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ABSTRACT

In self-adapted testing (SAT), examinees select the difficulty level of items administered. This study investigated three variations of prior information provided when taking an SAT: (1) no information (examinees selected item difficulty levels without prior information); (2) view (examinees inspected a typical item from each difficulty level prior to taking the SAT); and (3) route (examinees answered a typical item from each difficulty level and were informed prior to the SAT of the level that best matched their performance). Subjects were 218 students in an introductory statistics course, 85 percent of whom were undergraduates. No significant differences in test performance or anxiety were found as a function of providing examinees more information. Four tables are included. (Contains 9 references.) (Author/SLD)

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# Effects of Informed Item Selection on Test Performance and Anxiety for Examinees Administered a Self-Adapted Test

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Running head: SAT Item Selection

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# Effects of Informed Item Selection on Test Performance and Anxiety for Examinees Administered a Self-Adapted Test

## (Abstract)

In self-adapted testing (SAT) examinees select difficulty levels of items administered. This study investigated three variations of prior information provided when taking a SAT, (1) No Information: examinees selected item difficulty levels without prior information; (2) View: examinees inspected a typical item from each difficulty level prior to the SAT; (3) Route: examinees answered a typical item from each difficulty level and were informed prior to the SAT of the level that best matched their performance. No significant difference in test performance or anxiety was found as a function of providing examinees more information.

# Effects of Informed Item Selection on Test Performance and Anxiety for Examinees Administered a Self-Adapted Test

## Introduction

When an examinee is administered a typical computer adaptive test (CAT), an item selection algorithm is used to sequentially select items to administer to each examinee in order to tailor the test difficulty to the ability level of the examinee. One variant of CAT is self-adapted testing (SAT; Rocklin & O'Donnell, 1987). An examinee administered a SAT sequentially selects the level of difficulty of items to be administered, therefore personally tailoring the test to his or her own perceived ability level.

Under the item invariance property of item response theory (IRT), ability estimates should not be influenced by the difficulty of the items administered. Recent research comparing SAT to CAT, however, has found significantly higher ability estimates for examinees administered a SAT (Rocklin and O'Donnell, 1991; Roos, Plake and Wise, 1992; Wise, Plake, Johnson, and Roos, 1992; Vispoel and Coffman, in press).

The primary distinguishing feature between CAT and SAT is the involvement of the examinee in the item selection process in SAT. In the typical SAT administration, examinees are informed of relative difficulty levels of the items. Usually the distribution of item difficulties is broken into six or eight levels. The examinees may or may not be shown a typical item in the middle level of difficulty. Therefore, based on little (typical item from the middle difficulty level) or no information, examinees are asked to select the difficulty level for their first item to be administered. Research into the difficulty level

selection patterns for examinees administered a SAT under these conditions has shown little pattern of coherence (Johnson, Roos, Wise, and Plake, 1991).

The purpose of this study was to focus on this dimension of SAT: examinee selection of difficulty level. Three conditions of information potentially useful to examinees in making item difficulty selections were used:

Condition 1, No Information: Examinees were asked to sequentially select the difficulty level of the items to be administered with no prior information.

Condition 2, View: Examinees were shown a typical item from each of the six difficulty levels prior to being administered the SAT.

Condition 3, Route: Examinees were administered a typical item from each of the six difficulty levels and informed, as determined by a maximum likelihood estimate of their proficiency based on the six-item mini-test taken prior to the SAT, which level best matched their proficiency.

The following research questions were addressed in this study:

1. Does having more information about the test items affect examinee performance on the SAT?

2. Does having more information about the test items affect examinee anxiety when taking a SAT?

3. Does having more information about the test items affect examinee item difficulty level selection for the first item to be administered in the SAT?

## Method

### Subjects

Examinees were students in multiple sections of an Introduction to Statistics course in the Spring, 1993 semester at a large midwestern university. Students were required to take a Statistics Readiness Examination during the first week of class. Those students who score below a pre-determined cutoff were required to attend a one-hour mathematics review session the second week of class.

### Instruments

Statistics Readiness Test. Students were administered 20 items from a 91 item pool. These items were designed to measure basic algebra and mathematics reasoning necessary for successful completion of an introductory statistics class. The items were calibrated using a modified 1-parameter IRT model. More information about the item pool is presented in Wise et al. (1992). The SAT was administered using MicroCAT™ software (Assessment Systems Corporation, 1988).

Anxiety Instruments. Two instruments were administered to assess anxiety: The Revised Mathematics Anxiety Rating Scale (RMARS; Plake and Parker, 1982) and State scale of the State-Trait Anxiety Inventory (STAI; Spielberger, Gorsuch, and Lushene, 1970).

Background Questionnaire. A one-page questionnaire was administered that gathered student information regarding number of previous algebra classes and how recent that algebra coursework had been. The questionnaire also included questions pertaining to gender and age.

## Procedure

During the first day of class, students were informed of the testing requirement and asked to sign up for a testing time during the first week of classes. Also, during the first day of class, students filled out the background questionnaire and the RMARS.

Students were tested in a room containing 12 IBM PS/2 Model 55 microcomputers. Experimental conditions were randomly assigned to the 12 computers at the beginning of each of the four days of testing. When a student arrived at the testing center, a monitor greeted the students and allowed the student to select one of the available machines for testing.

Prior to beginning the test, the examinee was administered the State Anxiety scale of the STAI. Depending on the experimental condition, some examinees were given information about the difficulty of the items in the difficulty levels (View or Route conditions). For the Route condition, performance on the six practice items was not scored as part of the 20-item operational test. No time limit was imposed but most students finished the 20-item test in 20 - 25 minutes.

All students were given basic directions and informed that the items in the test fell into six difficulty levels, ranging from very easy to very hard. Before each item was administered, the student was instructed to select the difficulty level of their next item from the six levels. The items were randomly arranged within each difficulty level. If no items were remaining in the level selected

(there were 13 - 14 items available in each difficulty level at the start of the test administration), the student was informed that no items were available in that level and instructed to select another level. After answering each item, the student was informed of the correct answer for the item. This sequence of item difficulty level selection and student response continued until a total of 20 items was administered.

Upon completion of the test, the student was instructed to contact the monitor. The student was then again administered the State Anxiety scale of the STAI. Next, the student was informed whether or not he or she was required to attend the mathematics review session. The students were then thanked for their participation and dismissed.

## Results

### Subjects

A total of 218 students participated in the study, of which 85% were undergraduates and 15% graduate students. There were 92 males and 126 females.

**Research Question 1: Does having more information about the test items affect examinee performance on the SAT?**

Examinee performance on the Statistics Readiness Test is summarized in Table 1. An analysis of covariance, with RMARS as the covariate, was run to investigate differential test performance for the three conditions. A non-significant main effect for condition was found, $F(2, 204) = 0.13$, $p=.88$.

**Research Question 2: Does having more information about the test items affect examinee anxiety when taking a SAT?**

Examinee anxiety was investigated by a repeated measures analysis of variance, using pre and post measures from the State scale of the STAI. Means and standard deviations for post STAI are displayed in Table 2. A non-significant effect for condition was found, $F(2,204) = 0.21$, $p<.81$.

**Research Question 3. Does having more information about the test items affect examinee choice of the difficulty level selection for the first item to be administered in the SAT?**

Tables 3 and 4 summarize examinee choice of the difficulty level for the first item to be administered by the SAT. Table 3 shows the distribution of difficulty level selected for their first item by examinees in the three conditions. Table 4 shows the relationship between the proficiency level of examinees in the Route condition (as determined by a maximum likelihood estimate of their proficiency based on the six-item mini-test taken prior to the SAT) and their selection of difficulty level for the first SAT item.

A Chi-Square Test of Independence of choice of difficulty level for first SAT item by condition was significant ($X^2(10) = 28.83$, $p < .01$)). Pairwise follow-up tests revealed a non-significant relationship between choice of difficulty of first SAT item and condition for the View and Route conditions ($X^2(5) = 8.59$, $p < .15$). However, significant effects were found for the comparison between the No Information condition and each of the other conditions (View: $X^2(5) = 18.79$, $p < .01$; Route: $X^2(5) = 15.49$, $p < .01$)). Examinees in the View and Route conditions had a tendency to choose higher difficulty categories for their first SAT item than did examinees in the No Information condition; percentages of examinees selecting difficulty levels 4, 5 or 6 for the first SAT item were 47% for No

Information condition, 67% for the View condition, and 70% for the Route condition.

Further, examinees in the Route condition appear to have been influenced by the information provided to them about the difficulty level that best matched their proficiency: 78% of the candidates selected as the difficulty level for their first item the same difficulty level identified as the one that best matched their proficiency level. Therefore, the level of difficulty selected for their first SAT item by these examinees appears to have been affected by the information provided to them by the short mini-test. This appeared to be good advice as 75% of these examinees, across the six difficulty levels, correctly answered the first item they were administered. Examinees in the View (80%) and No Information (72%) conditions also showed high succes in answering the first item in the SAT correctly. However, because examinees in the No Information condition were more likely to select items from the lower difficulty levels for their first SAT item, this high level of success could be a function of the tendency to select easier difficulty categories for their first SAT item.

## Discussion

Examinee performance and anxiety did not appear to be influenced by having more information about the difficulty levels or by additional information about the match of the examinee proficiency to item difficulty level. It could be that these students, as advanced undergraduate and graduate students, were sufficiently self-knowledgeable of ability in this area to not require additional information for making item difficulty level selections.

The choice of the first difficulty level for the SAT, though, was influenced by information provided to the examinees about the difficulty level that was the best match to their proficiency level. While this appeared to be good advice, as

the examinees tended to perform well on the item administered as their first test question, the effect of the information about their proficiency level and the difficulty levels of the items did not have a noticeable effect on overall proficiency estimates for the students in the Route condition as compared to that of students in the other information conditions. It is interesting to note, however, that the students in the Route condition showed the highest overall estimation of ability and also the highest level of post state anxiety. The higher scores, however, were not significantly different from those for examinees in the other two conditions.

Most of the research in SAT has been done on college-aged students. It is possible that these students are self-knowledgeable of their abilities and therefore do not make different item difficulty selection decisions when given additional relevant information. The generalizability of the SAT research to less sophisticated students needs to be addressed.

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Table 1

Means and Standard Deviations of Estimated Ability (Theta) Broken Down by Information Condition

| | Condition | | |
|---|---|---|---|
| | No Information | View | Route |
| N | 68 | 71 | 79 |
| Mean | 0.438 | 0.448 | 0.586 |
| sd | 1.300 | 1.127 | 1.280 |

Table 2

Means and Standard Deviations of Post Anxiety Broken Down by Information Condition

| | Condition | | |
|---|---|---|---|
| | No Information | View | Route |
| N | 68 | 71 | 79 |
| Mean | 38.82 | 38.00 | 39.43 |
| sd | 11.37 | 11.45 | 12.33 |

Table 3

Number of Examinees by Condition Selecting Each of the Six Difficulty Levels for their First Item SAT

| | Difficulty Level of First Item Selected | | | | | | |
|---|---|---|---|---|---|---|---|
| Condition | 1 | 2 | 3 | 4 | 5 | 6 | Total |
| No Information | 6 | 5 | 25 | 16 | 6 | 10 | 68 |
| View | 2 | 13 | 9 | 18 | 16 | 13 | 71 |
| Route | 6 | 6 | 12 | 14 | 17 | 24 | 79 |
| TOTAL | 14 | 24 | 46 | 48 | 39 | 47 | 218 |

Table 4

Number of Examinees by Proficiency Level in the Route Condition Selecting Each of the Difficulty Categories as Their First SAT Item

| | Difficulty Level Selected for First Item in SAT | | | | | | |
|---|---|---|---|---|---|---|---|
| Proficiency Level | 1 | 2 | 3 | 4 | 5 | 6 | Total |
| 1 | 3 | 1 | | | | | 4 |
| 2 | | 3 | 1 | | | | 4 |
| 3 | 1 | 1 | 6 | | | | 8 |
| 4 | | 1 | 3 | 8 | | | 12 |
| 5 | 2 | | 1 | 3 | 13 | 4 | 23 |
| 6 | | | 1 | 3 | 4 | 20 | 28 |
| TOTAL | 6 | 6 | 12 | 14 | 17 | 24 | 79 |